

Chapter 3

Design Aids/Standard Forms



Figure 3.1 The bin size required is dependent not only the volume of compost, but also on the size and type of mechanical equipment that will be used in the operation.

General

The size of a composting facility should be determined according to Chapter 10 of the Agricultural Waste Management Field Handbook (NRCS 1992). The actual bin size should be determined by the planner. Once the bin size is known, the planner can use the member sizing charts on the following pages to select the appropriate member sizes.

Effects of Bracing

Lateral bracing (or knee bracing) is used to increase rigidity in the post-to-rafter or post-to-truss connections. Analysis performed for the development of this handbook shows that bracing reduces the required member size of the rafters, but infrequently affects post size for the shed-type composters, shown in Figure 3.2, page 3-5. Only the posts in the 100 mph wind zone are reduced by bracing.

The post sizes in the other zones remain the same for this building configuration. Details on how to connect the braces are included with the Construction Drawings in Appendices.

Analysis shows that the required post size for partially open and enclosed gable-end composters and stacking sheds decreases when braces are used to connect the truss to the post. For the partially open stacking sheds, a braced as well as an unbraced alternative is given in this handbook.

Maximum Constraints

The study performed to develop the member sizing charts used the stiffness matrix analysis method. Fourteen feet was the maximum height analyzed for composters or stacking sheds.

The maximum primary bin length analyzed in the shed-type composters was eight feet.

The maximum primary and secondary bin widths analyzed in the shed-type composters were 12 feet.

Forty feet was the maximum width (span on gable end) of the Gable-end composters and stacking sheds.

The only bin wall height analyzed was five feet.

The following tables and figures are valid only for the specific buildings that were analyzed. Any variations exceeding these constraints would need an individual design.

Frame Connection Details

Figure 3.9 for composters (page 3-15) and Figure 3.11 for stacking sheds (page 3-20) tabulate the correct number of fasteners for each type of frame connection. These connections are post-to-rafter (or truss), girder-to-post and knee brace-to-post/rafter (or truss). The number of fasteners was determined based on the uplift, shear and axial member forces provided by the analysis. The number of fasteners is based on the allowable load (single shear) per bolt or nail. The following assumptions apply to the table:

- Bolt diameter = 5/8"
- Nail diameter = 0.177"
- Bolt allowable load = 896 lb/bolt
- Nail allowable load = 320 lb/nail

The allowable loads are given in the National Design Specification for Wood Construction (NDS) for steel bolts and threaded hardened-steel nails. Wind load adjustment factors have been applied to the values shown above.

Bolts should be installed so that the bolt is 1" (1.5D) from the edge of the member with 2.5" (4D) spacing between bolts and 2.5" (4D) from the end of the member. Bolt holes should be a minimum of 1/32" larger than the bolt but no more than 1/16" larger. Forceful driving of bolts is not recommended. Washers are required at the head and nut. Nails do not have defined spacings but should be installed in a manner that will not split the wood. Threaded nails 0.177" in diameter can be obtained in lengths from 4" (20d) to 6" (60d).

Once the type of building and rafter spacing for the building are known, the planner will select the number of fasteners from the

fastener schedule. The table shows the number of fasteners needed if the planner uses,

1. all bolts,
2. a combination of nails and bolts,
3. nails only.

Post Embedment

Post embedment shall be as shown on the drawings generally between 4 and 5 ft deep, with hole diameter of 1 to 2.5 feet. Analysis of these buildings indicates that the use of concrete bearing pads to resist downward loads is required and the use of a concrete bottom collar to resist uplift is required. Fully encasing posts in concrete is only necessary for stacking sheds.

Design Aids

Member Sizing Charts

The member sizing charts are all based on roof slopes of 4:12 or flatter. All lumber dimensions are nominal, and the sizes are based on No. 2 Southern Pine lumber. No. 2 Non-Dense is not acceptable.

The member sizing charts are based on the wind speed zone where the proposed structure would be located ([Table 1](#), pages 2-7 and 2-8) and the bin sizes desired. The dimensions used in the analysis and in this handbook are defined in [Figure 3.2](#) on page 3-5, and [Figure 3.3](#) on page 3-6. Secondary bin widths in the following designs are **always** the same as the corresponding primary bin widths. The primary bin length is a maximum of eight feet.

Any post spacing or span **less** than what is given is also acceptable for the same size member listed in the chart. An eight foot

primary bin width is acceptable, therefore, but the member sizes for a ten foot primary bin width must be used since a ten foot primary bin width is the minimum given.

The landowner is also given a choice as to whether he or she wants to use lateral bracing to connect the post to the rafters (See [Figure 3.2](#)). Lateral braces are 2x4s unless otherwise specified.

As the planner selects the proper member sizes, he or she should record them on the Design Dimension worksheet, given on page 3-16 for composters and page 3-21 for stacking sheds. Complete construction drawings are included in the appendices and construction specifications are found in Chapter 4.

The following member sizing charts are included in this chapter:

- Composter A - Without Bracing
- Composter A - Braced
- Composter B - Without Bracing
- Composter B - Braced
- Composter C - Without Bracing
- Summary of Connection Details for Composters A-C
- Stacking Shed A (Partially Open)
- Stacking Shed A (Partially Open) - Braced
- Stacking Shed B (Enclosed) - Without Bracing
- Summary of Connection Details for Stacking Sheds

Standard Forms

The following forms are included in this handbook, and are intended to be reproduced at the field office level to assist in the planning of a waste management building. The reproduced forms, completed with the appropriate data, along with the appropriate set of construction drawings from the Appendices, should then be sent to the field engineer for approval.

- Design Dimension Worksheet for Shed-Type Dead Animal Composting Facility (page 3-16). *Use this form for Composter A and Composter B.*
- Design Dimension Worksheet for Gable-end Composters and Stacking Sheds (page 3-21). *Use this form for Composter C and all Stacking Sheds.*
- Truss Fabrication Parameters (page 3-22 and 3-18). *Use this form for Composter C and all Stacking Sheds.*
- A Construction Checklist (page 4-12 and 4-13). *Use this form for all Composters and Stacking Sheds.*

All sketches shown in Chapter 3 of this handbook are conceptual in nature. Do not use them for construction. Connection, roof overhang, and slab details can be found in the construction drawings in the Appendices to this handbook.

Definition of Dimensions for Shed-type Composters

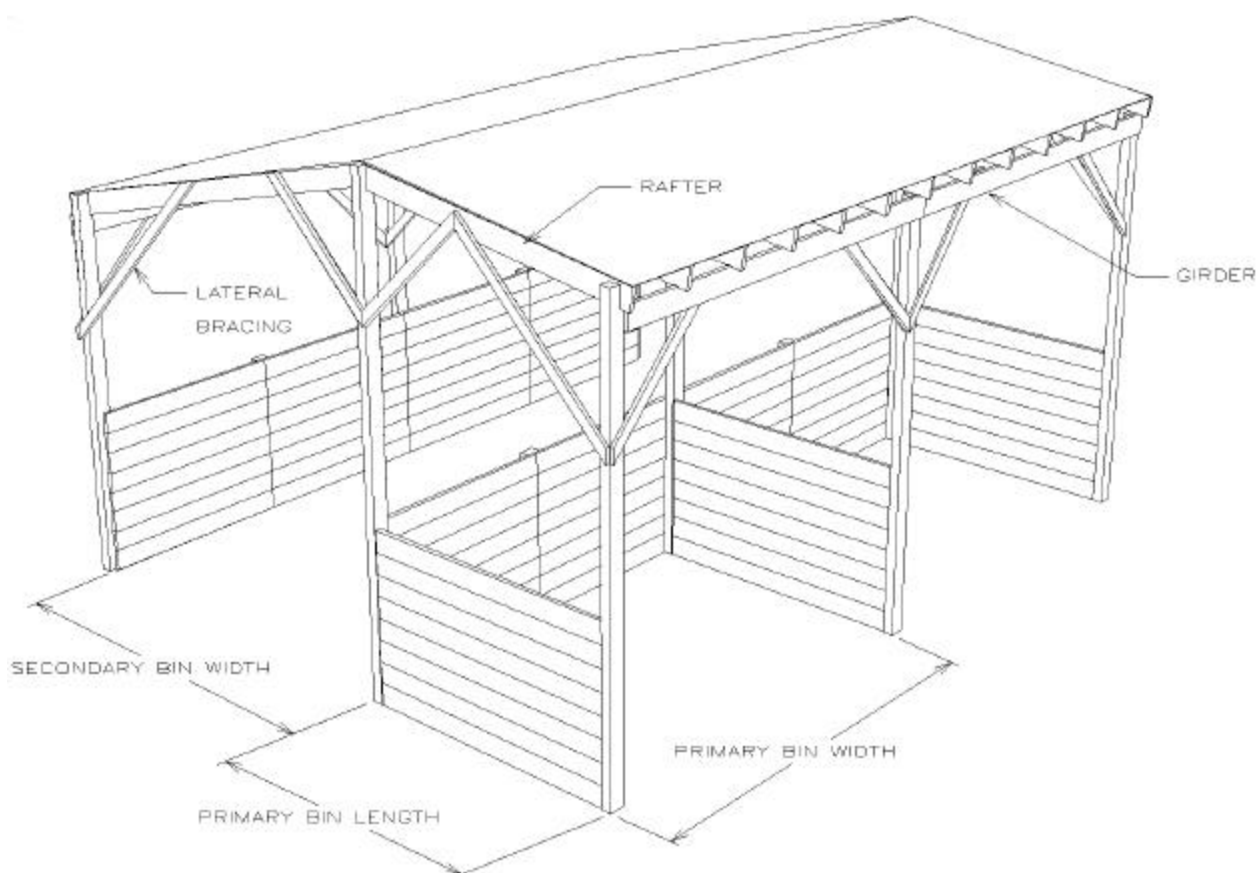


Figure 3.2 Dimension definition sketch for composters. The member sizing charts on the following pages refer to the “Primary Bin Width” as defined above. In the structures analyzed for this handbook, the Secondary Bin Width equals the Primary Bin Width.

Dimensions for Gable-end Composters and Stacking Sheds

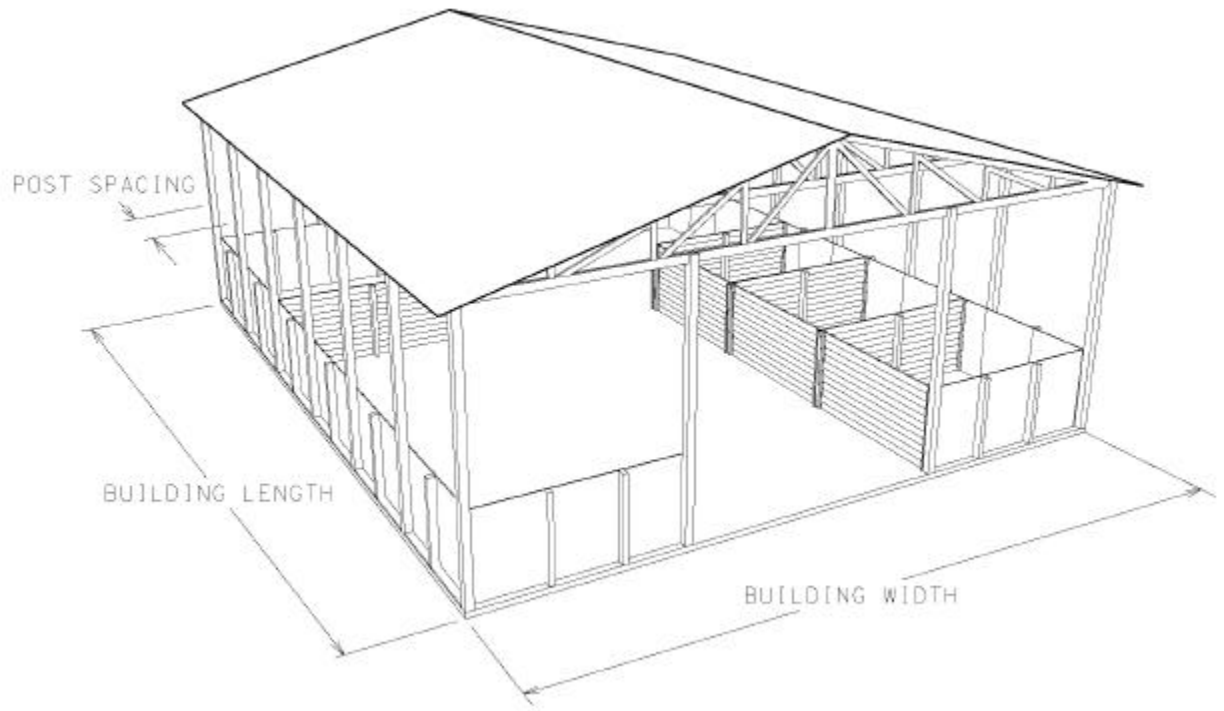


Figure 3.3 Dimension definition sketch for stacking shed/composter combination. The member sizing charts on the following pages refer to the “Building Width” and “Post Spacing” above.

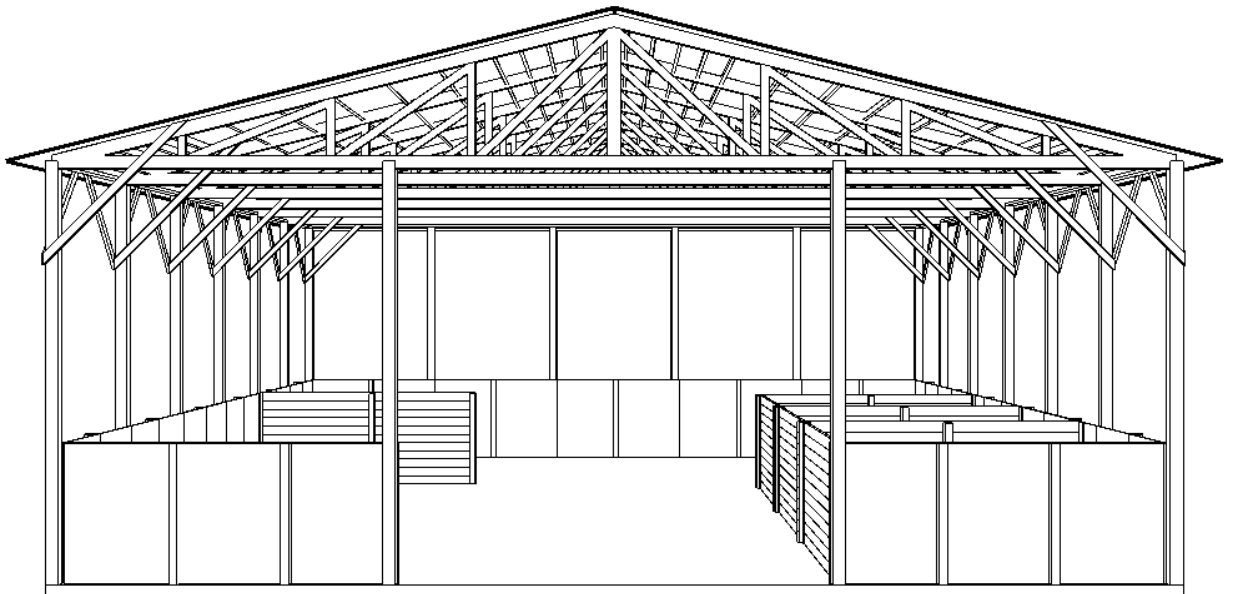


Figure 3.4 Conceptual sketch of a braced stacking shed/composter combination.

Optional features for Shed-type Composters

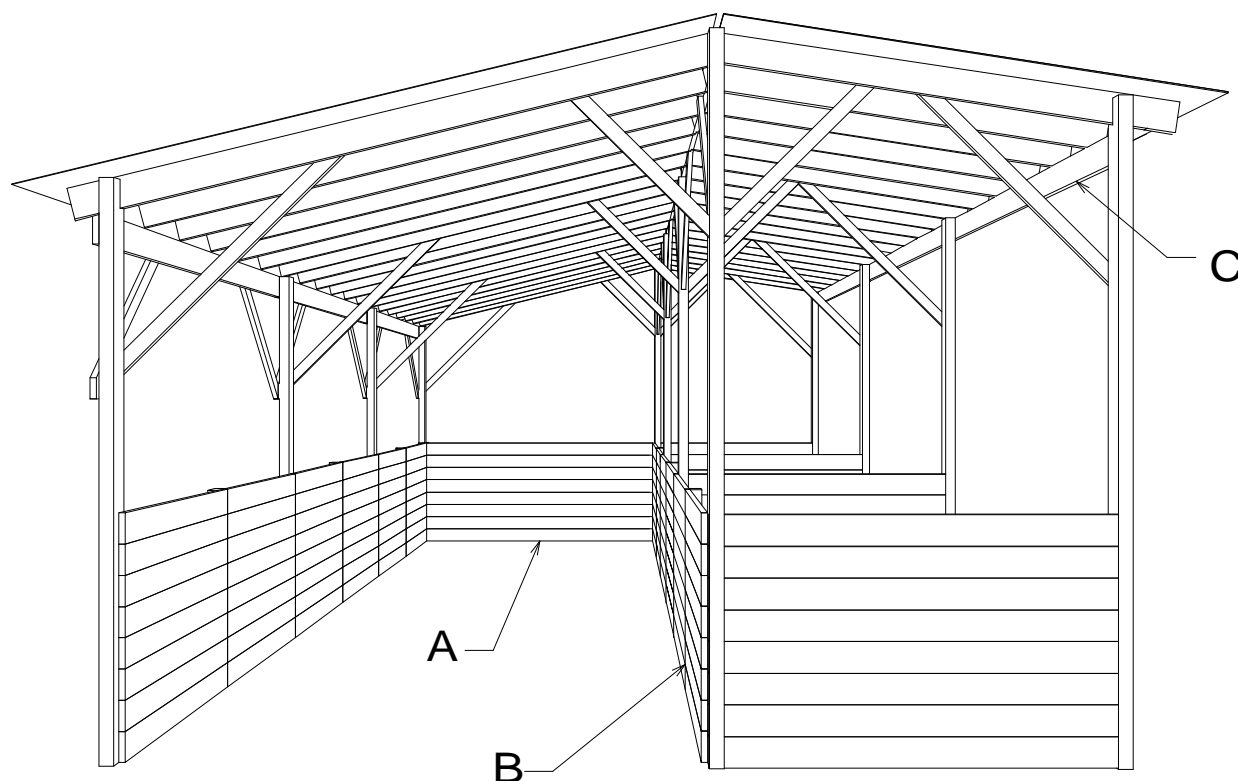


Figure 3.5

- A. The side wall shown on one side of the secondary bin is optional. The absence or presence of this wall will not affect the member sizes given in the member sizing charts in this Chapter.
- B. The bin wall may go on either side of the cut-off post. Placing the bin wall on the inside of the post (in the primary bin) prevents nail withdrawal problems associated with the lateral pressure applied to the wall by the compost. The bin wall may be placed on the outside of the post (in the secondary bin) if the producer wishes, however, since no damage to the main structure would occur in the event of the bin wall failure.
- C. Lateral bracing between the front posts and the front girder may be omitted if the braces would interfere with the loading or unloading of the primary bins. If members are selected from the member sizing charts for a braced design, all other lateral braces in all directions should be installed.

Edgewise Purlins

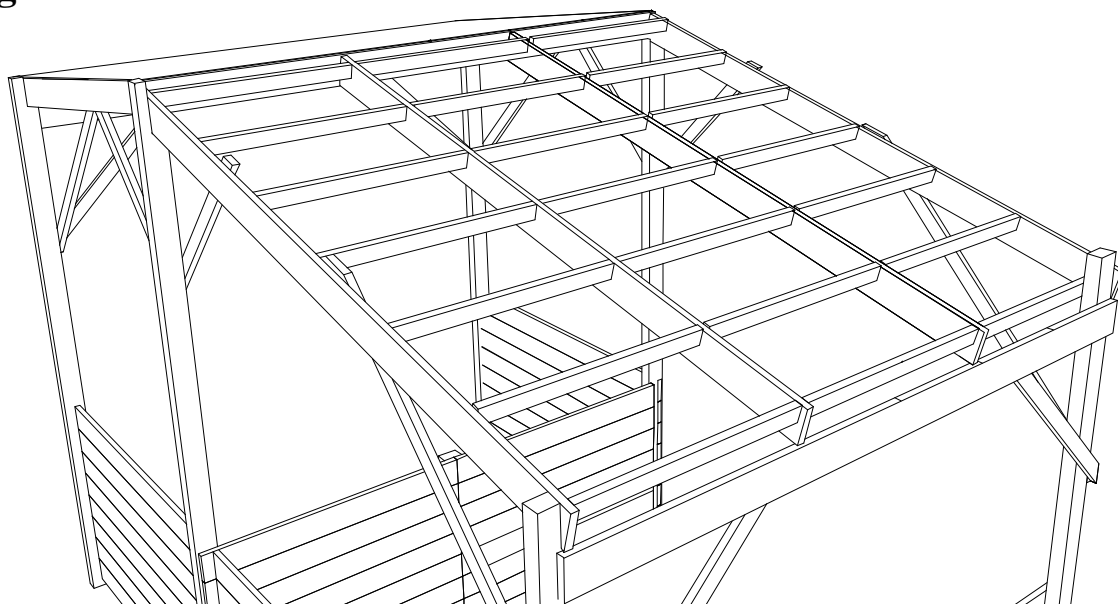


Figure 3.6 For roof purlins recessed and turned edgewise, toenailing or hangers are acceptable ways of fastening purlins to rafters. 2x4 purlins may also be nailed on top of the rafters with one 60-d nail or attached with metal clips at each rafter. Rafters may be spaced up to twelve feet, dependent on purlin size, when purlins are turned edgewise. See purlin chart on page 3-9.

Flat Purlins

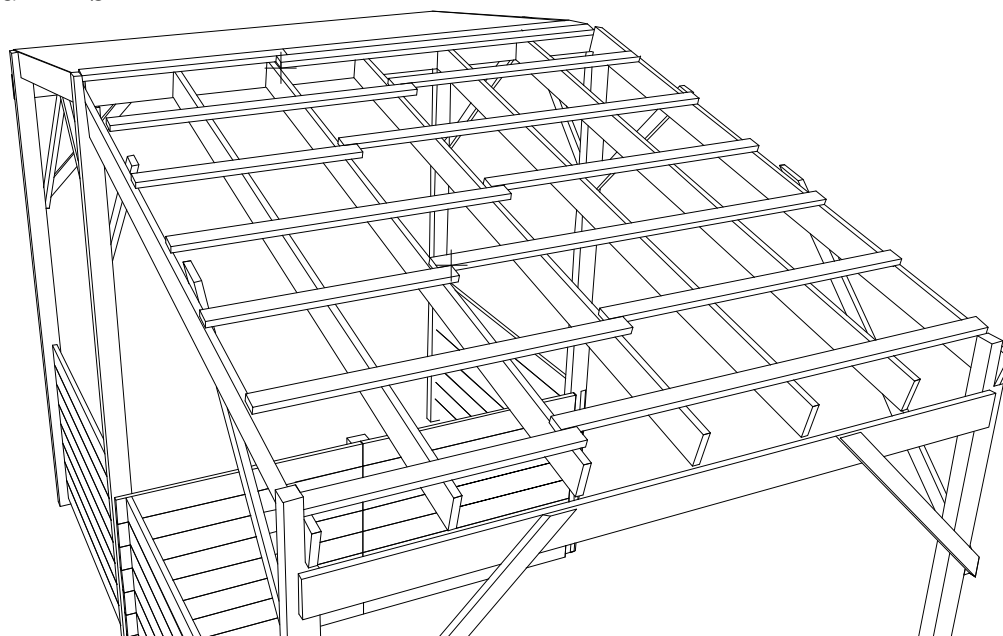


Figure 3.7 If nailing roof purlins flat, rafters may not be spaced more than two feet. Lapping the purlins, as shown above, allows the best connection and is the preferred method if flat purlins are used. Use two 10d ring shank nails in the purlin-rafter connection.

Flat Purlins (continued)

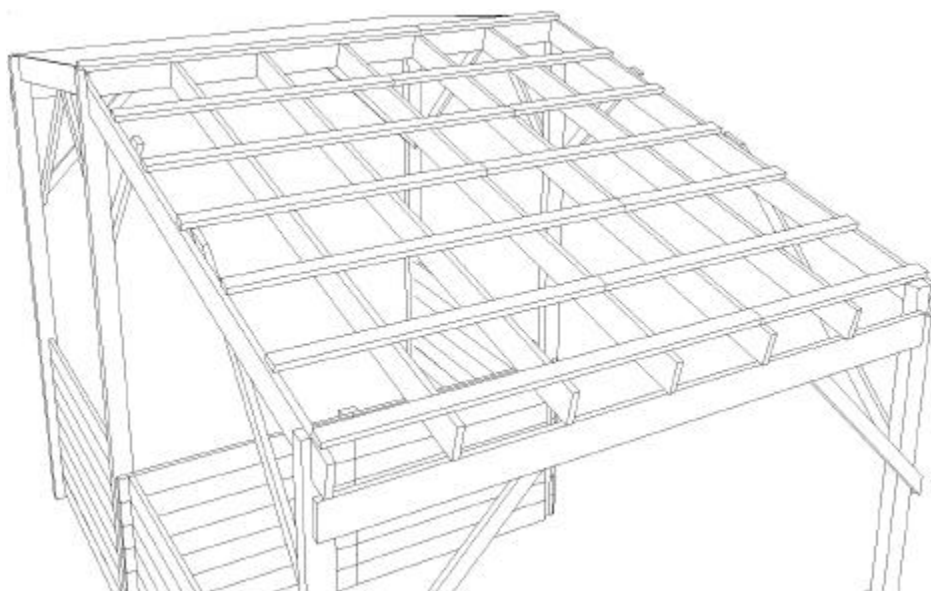


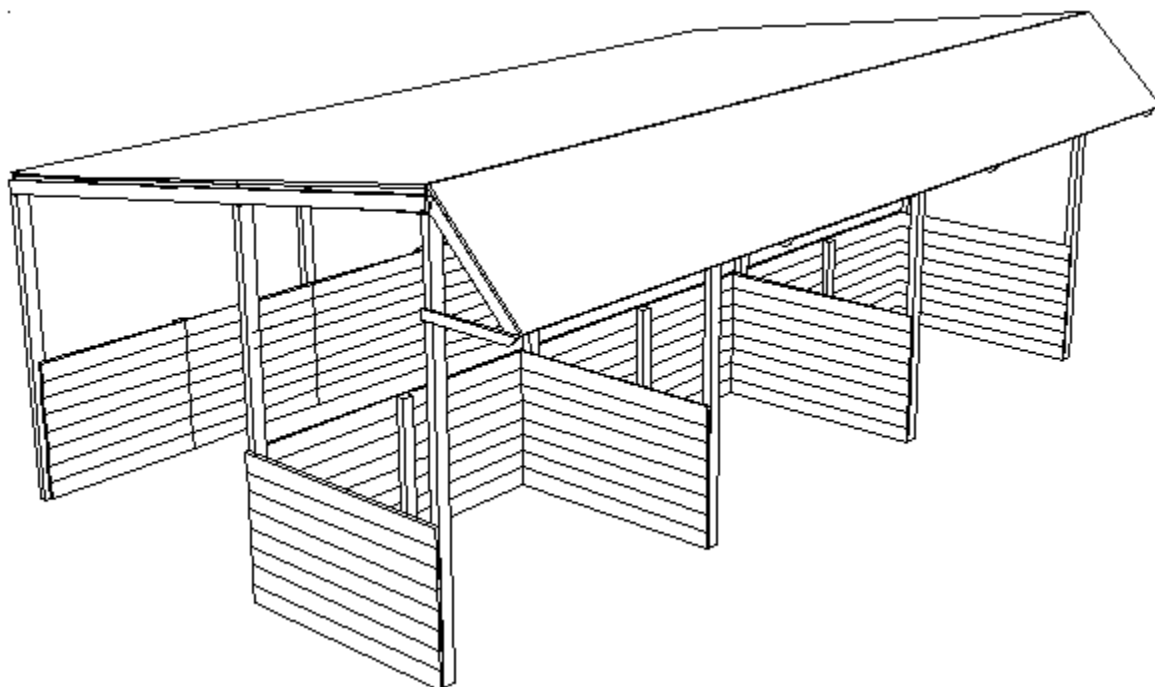
Figure 3.8 Purlins may also be butt-jointed if the joints are staggered as shown above. Rafters may not be spaced more than two feet with this method. Use two 10d ring shank nails in the purlin-rafter connection.

Purlin sizing and spacing^{1, 2}

The following guidelines apply to all buildings in this handbook.

Wind Speed	size	2x4		2x6	2x8
	span	2'	5'	5'-12'	12'
90 mph		30" ³	30"	30"	30"
100 mph		30" ³	30"	30"	30"
110 mph		30" ³	30"	24"	30"
120 mph		30" ³	30"	18"	30"
125 mph		30" ³	30"	18"	30"

1. Purlin spacings shown in chart (in inches) are for interior roof zones. Reduce spacing to ½ of that shown for edge zone (within 3 feet of roof edge and peak) to resist wind forces due to edge discontinuities.
2. Purlin spacings are for ¾" ribbed roof panels. Maximum spacing for 5V Crimp roof panels is 24" in wind zones 90-110 mph, and 18" in wind zones 120-125 mph.
3. Flatwise. All other purlins shall be installed edgewise.



Composter A - Without Bracing¹

10 Foot Primary & Secondary Bin Widths

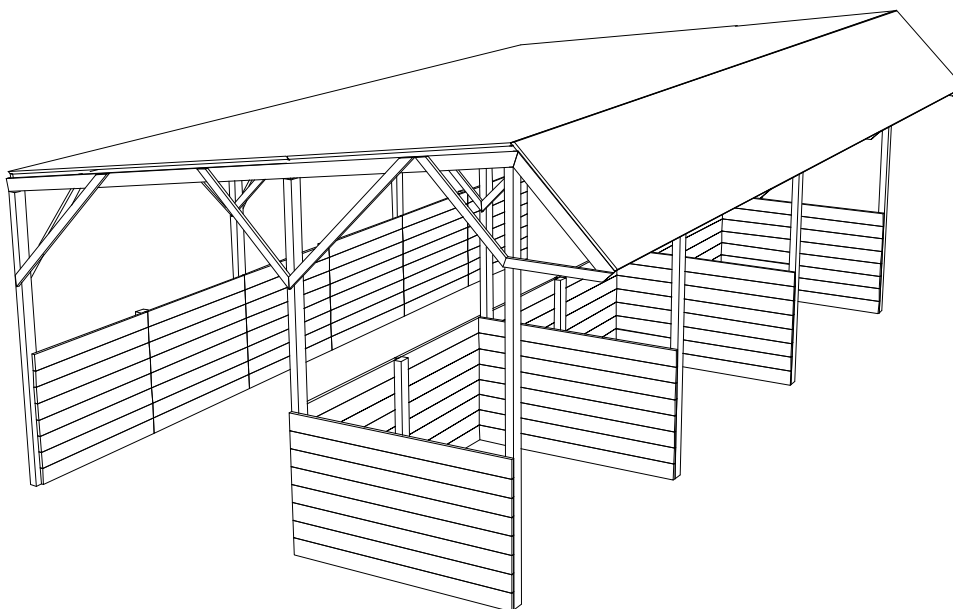
Wind Speed	Member Size		
	Post	Rafter ²	Girder
90	4x4	2x8	2x8
100	4x6	2x8	2x10
110	4x6	2x10	2-2x8
120	4x6	2-2x8	2-2x8
125	4x6	2-2x8	2-2x8

12 Foot Primary & Secondary Bin Widths

Wind Speed	Member Size		
	Post	Rafter ²	Girder
90	4x4	2x8	2-2x8
100	4x6	2x10	2-2x8
110	4x6	2-2x8	2-2x10
120	4x6	2-2x8	2-2x12
125	4x6	2-2x8	2-2x12

¹ See Purlin Sizing and Spacing, page 3-9, for purlin sizing details.

² Rafter sizes given in chart are for rafters connected at the posts. Intermediate rafters shall be *single* members of the same dimensions as the rafters at the posts.



Composter A - Braced¹

10 Foot Primary & Secondary Bin Widths

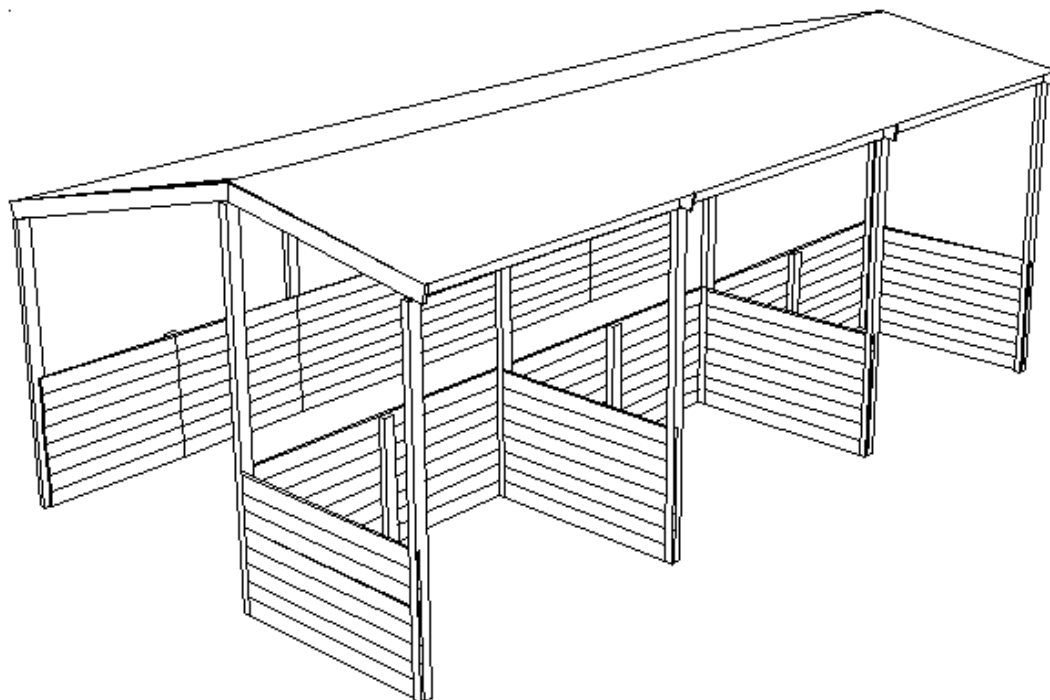
Wind Speed	Member Size		
	Post	Rafter ²	Girder
90	4x4	2x6	2x10
100	4x4	2x6	2x10
110	4x6	2x6	2-2x8
120	4x6	2x6	2-2x8
125	4x6	2x6	2-2x8

12 Foot Primary & Secondary Bin Widths

Wind Speed	Member Size		
	Post	Rafter ²	Girder
90	4x4	2x8	2-2x8
100	4x6	2x8	2-2x8
110	4x6	2x8	2-2x10
120	4x6	2x8	2-2x12
125	4x6	2x8	2-2x12

¹ See Purlin Sizing and Spacing, page 3-9, for purlin sizing details.

² Rafter sizes given in chart are for rafters connected at the posts only. . Intermediate rafters shall be *single* members of the same dimensions as the rafters at the posts.



Composter B - Without Bracing¹

10 Foot Primary & Secondary Bin Widths

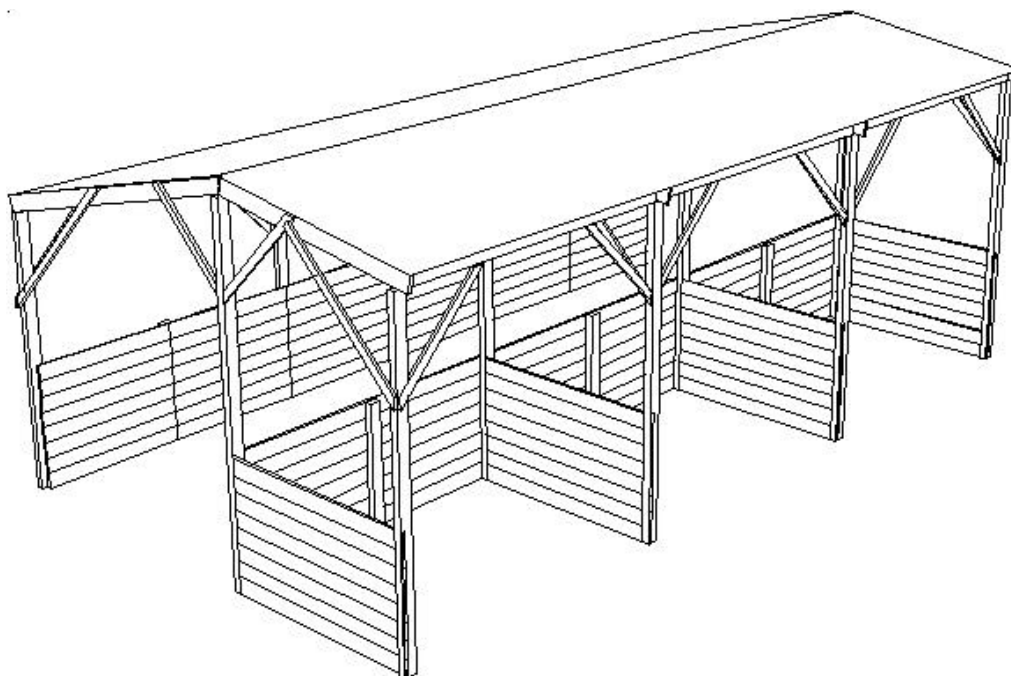
Wind Speed	Member Size		
	Post	Rafter ²	Girder
90	4x4	2x8	2x8
100	4x6	2x8	2x10
110	4x6	2x10	2-2x8
120	4x6	2-2x8	2-2x8
125	4x6	2-2x8	2-2x8

12 Foot Primary & Secondary Bin Widths

Wind Speed	Member Size		
	Post	Rafter ²	Girder
90	4x4	2x8	2-2x8
100	4x4	2x10	2-2x8
110	4x6	2-2x8	2-2x10
120	4x6	2-2x8	2-2x12
125	4x6	2-2x8	2-2x12

¹ See Purlin Sizing and Spacing, page 3-9, for purlin sizing details.

² Rafter sizes given in chart are for rafters connected at the posts only. . Intermediate rafters shall be *single* members of the same dimensions as the rafters at the posts.



Composter B - Braced¹

10 Foot Primary & Secondary Bin Widths

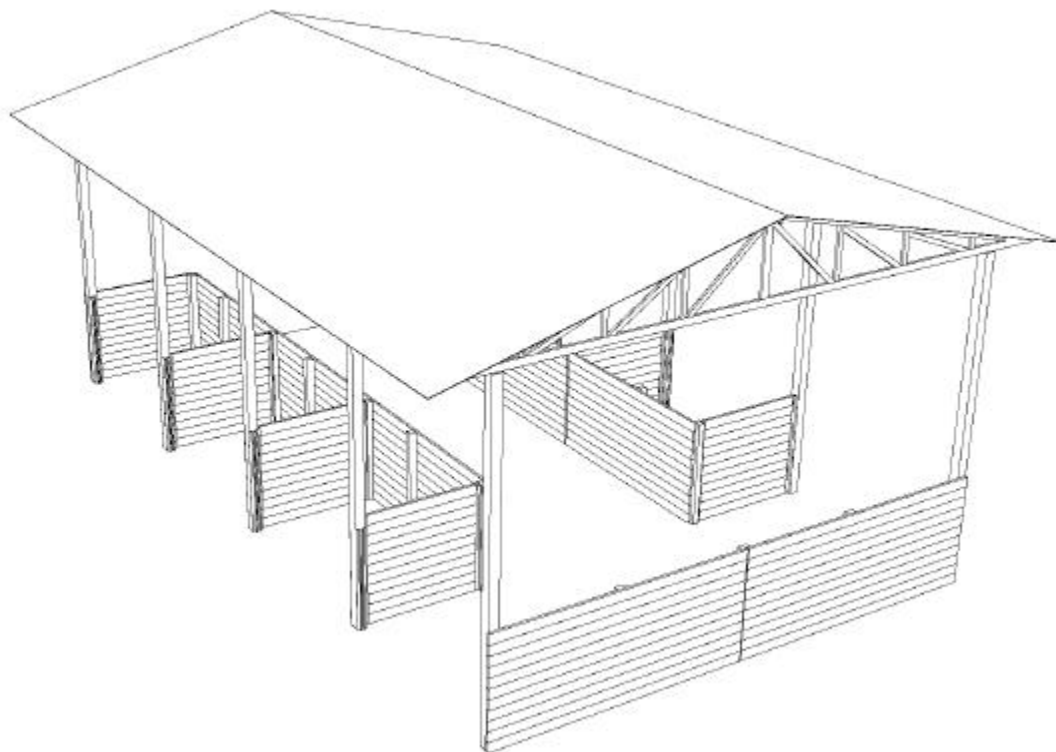
Wind Speed	Member Size		
	Post	Rafter ²	Girder
90	4x4	2x6	2x10
100	4x4	2x6	2x10
110	4x6	2x6	2-2x8
120	4x6	2x6	2-2x8
125	4x6	2x6	2-2x8

12 Foot Primary & Secondary Bin Widths

Wind Speed	Member Size		
	Post	Rafter ²	Girder
90	4x4	2x8	2-2x8
100	4x6	2x8	2-2x8
110	4x6	2x8	2-2x10
120	4x6	2x8	2-2x12
125	4x6	2x8	2-2x12

¹ See Purlin Sizing and Spacing, page 3-9, for purlin sizing details.

² Rafter sizes given in chart are for rafters connected at the posts only. . Intermediate rafters shall be *single* members of the same dimensions as the rafters at the posts.



Composter C - Without Bracing

Maximum 28 foot span

Wind Speed	Member Size ¹	
	Post	Girder
90	4x6	2x8
100	4x6	2x8
110	4x6	2x8
120	4x6	2x8
125	4x6	2x8

¹ See Purlin Sizing and Spacing, page 3-9, for options on roof purlins.

Fastener Schedule **for Composters A-C**

POST-TO-RAFTER/TRUSS CONNECTION						GIRDER-TO-POST		KNEE BRACE-TO-POST/TRUSS/RAFTER		
Composter	Truss/ Rafter Spacing	Wind Speed	# Bolts	# Bolts/ # Nails	# Nails	# Bolts	# Nails	# Bolts	# Bolts/ # Nails	# Nails
A&B	12	90	3	1/4	7	-	2	2	1/3	5
		100	3	2/3	8	-	2	3	1/4	7
		110	4	2/5	10	-	2	3	1/4	7
		120	5	3/4	13	-	2	4	2/4	10
		125	5	3/5	14	-	2	4	2/5	10
	6	90	2	1/1	4	-	2	-	-	-
		100	2	1/2	4	-	2	-	-	-
		110	2	1/3	5	-	3	-	-	-
		120	3	1/4	7	2	4	-	-	-
		125	3	1/5	7	2	4	-	-	-
	2	90	1	-	1	-	3	-	-	-
		100	1	-	2	2	4	-	-	-
		110	1	-	2	2	5	-	-	-
		120	1	-	3	2	6	-	-	-
		125	1	-	3	2	6	-	-	-
C	10	90	3	2/3	8	-	2	-	-	-
		100	4	2/5	10	-	2	-	-	-
		110	5	3/4	12	-	2	-	-	-
		120	6	4/4	15	-	2	-	-	-
		125	7	4/7	18	-	2	-	-	-
	5	90	2	1/2	4	-	2	-	-	-
		100	2	1/3	5	-	3	-	-	-
		110	3	1/4	6	2	3	-	-	-
		120	3	1/5	8	2	4	-	-	-
		125	4	1/6	9	2	5	-	-	-

Figure 3.9 (See page 3-2 for explanation of fastener schedule)

DESIGN DIMENSION WORKSHEET FOR SHED-TYPE DEAD ANIMAL COMPOSTING FACILITY

NAME _____ COUNTY _____ STATE _____

DATE _____ PURPOSE _____

WIND ZONE _____ (**Figure 2.5**, page 2-6 or **Table 1**, page 2-7 & 2-8)

TYPE OF STRUCTURE

(circle one) Composter A Composter B

(circle one) Laterally Braced Not Braced

POST DESIGN

Maximum Post Height _____ (feet) - **Not to exceed 14 feet**

Primary Bin Width _____ (feet) - **Not to exceed 12 feet**

Secondary Bin Width _____ (feet) - **Not to exceed 12 feet, or not to exceed 10 feet
when Primary Bin = 10 feet**

Primary Bin Depth _____ (feet) - **Not to exceed 8 feet**

Post Size _____ (Member Sizing Charts)

RAFTER DESIGN

Rafter Size _____ (Member Sizing Charts)

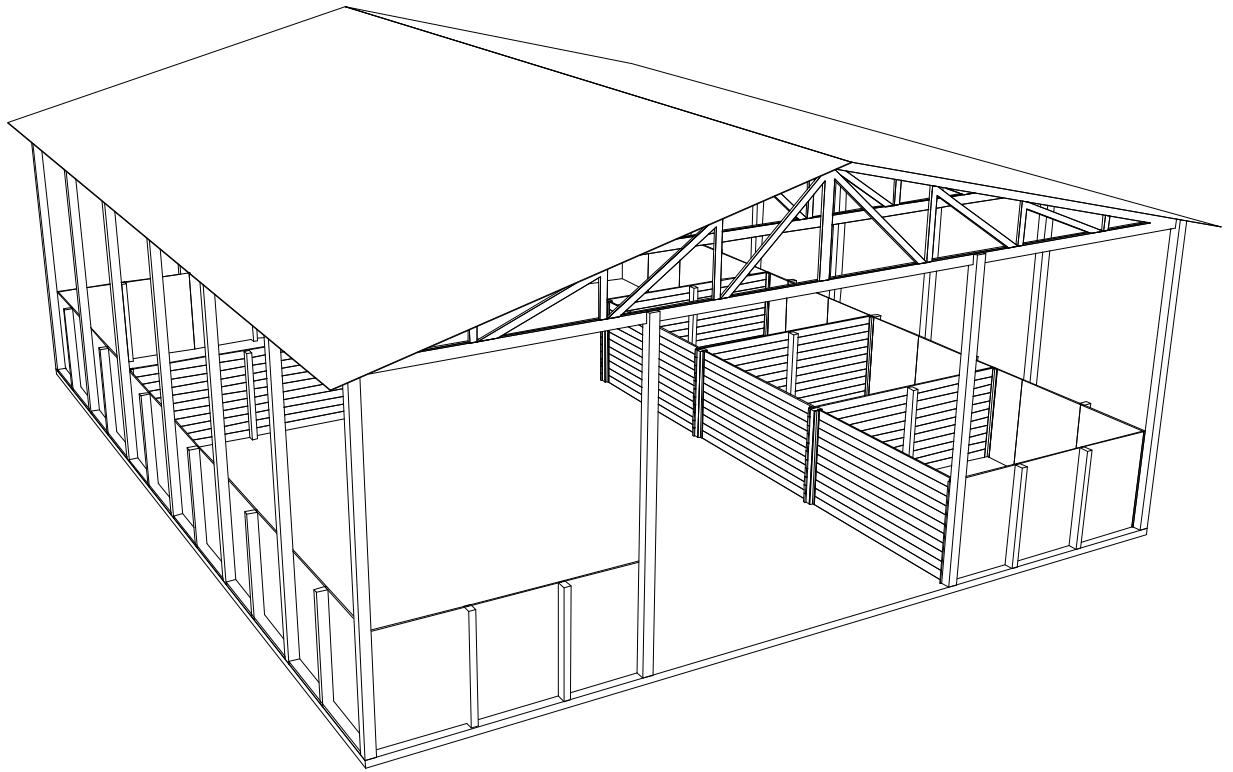
Girder Size _____ (Member Sizing Charts)

Girder Spacing _____ (Member Sizing Charts)

Roof Purlins: 2x4s spaced at ___ feet (edgewise flatwise)

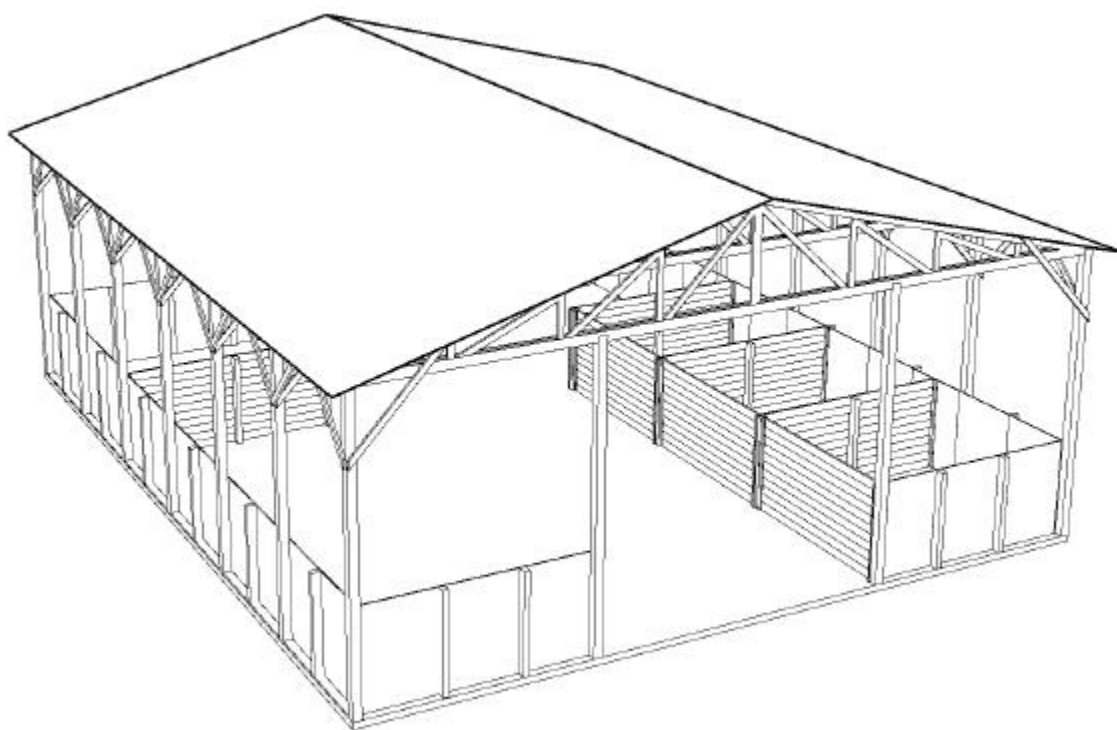
Planned By _____

Approved By _____



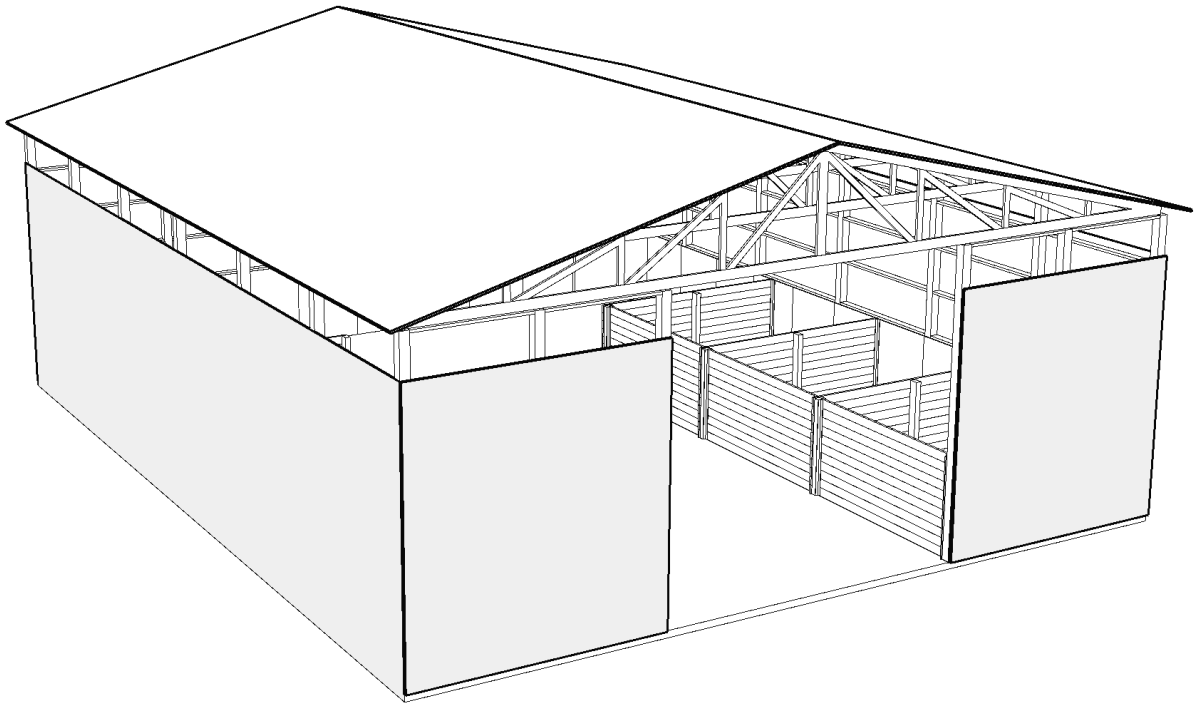
Stacking Shed A - Without Bracing **8 Foot Post Spacing**

	Wind Speed	Post Size			Girder Size
Span		32 ft.	36 ft.	40 ft.	All Spans
	90	4x6	4x6	6x8	2-2x6
	100	6x6	6x8	6x8	2-2x8
	110	6x8	6x8	6x8	2-2x8
	120	6x8	6x8	8x8	2-2x10
	125	6x8	8x8	8x8	2-2x10



Stacking Shed A - Braced **8 Foot Post Spacing**

	Wind Speed	Post Size			Girder Size
Span		32 ft.	36 ft.	40 ft.	All Spans
	90	4x6	4x6	6x8	2-2x6
	100	4x6	4x6	6x8	2-2x8
	110	4x6	6x8	6x8	2-2x8
	120	6x8	6x8	6x8	2-2x10
	125	6x8	6x8	8x8	2-2x10



Stacking Shed B - Enclosed **8 Foot Post Spacing**

		Wind Speed	Post Size			Girder Size
Span			32 ft.	36 ft.	40 ft.	All Spans
	90	6x8	6x8	6x8	6x8	2-2x6
	100	6x8	6x8	8x8	8x8	2-2x8
	110	8x8	8x8	8x8	8x8	2-2x8
	120	8x8	8x8	10x10	10x10	2-2x10
	125	8x8	10x10	10x10	10x10	2-2x10



Figure 3-10. An example of a typical combined nail/bolt connection.

Fastener Schedule **for Stacking Sheds**

POST-TO-TRUSS CONNECTION					GIRDER-TO-POST		KNEE BRACE-TO-POST/TRUSS		
Truss/ Rafter Spacing (feet)	Wind Speed (mph)	# Bolts	# Bolts/ # Nails	# Nails	# Bolts	# Nails	# Bolts	# Bolts/ # Nails	# Nails
8	90	3	2/3	9	-	2	2	1/1	4
	100	4	2/5	11	-	2	2	1/2	5
	110	5	4/2	13	-	2	3	1/4	6
	120	6	4/4	16	-	2	3	2/2	8
	125	6	4/6	17	-	2	3	2/3	9
4	90	2	1/2	5	-	2	2	1/1	4
	100	2	1/3	6	-	3	2	1/2	5
	110	3	1/4	7	2	4	3	1/4	6
	120	3	2/2	8	2	4	3	2/2	8
	125	3	2/3	9	2	5	3	2/3	9

Figure 3-11 (See page 3-2 for explanation of fastener schedule)

DESIGN DIMENSION WORKSHEET FOR GABLE-END COMPOSTERS AND STACKING SHEDS

NAME _____ COUNTY _____ STATE _____

DATE _____ PURPOSE _____

WIND ZONE _____ (**Figure 2.5**, page 2-6 or **Table 1**, pages 2-7 & 2-8)

TYPE OF STRUCTURE

(circle one) Composter C Stacking Shed A Stacking Shed B

(circle one) Partially Open Enclosed

(circle one) Laterally Braced Not Braced

POST DESIGN

Maximum Post Height _____ (feet) - **Not to exceed 14 feet**

Post Size _____ (Member Sizing Charts)

TRUSS DESIGN

Complete Truss Manufacturer's Form

Planned By _____

Approved By _____

TRUSS FABRICATION PARAMETERS (SPECIFICATION SHEET FOR TRUSS FABRICATORS)

The NRCS Planner should complete this form.

Truss fabricators are asked to return the form signed, indicating that all specifications have been included in the manufacture of the trusses.

Project/Landowner: _____

Span (Outside wall to outside wall): _____ ft. _____ in.

Top chord pitch : _____ in 12

Bottom chord pitch : _____ in 12 (for scissor truss)

Truss spacing : _____ ft. _____ in.

Purlin spacing : _____ in.

Overhangs : _____ ft. _____ in. (1 foot minimum)

Gable trusses are Structural (no continuous vertical support as in a stud wall).

Roof Live Load : 10 psf (governs over snow load)

Post-Truss/Rafter connection : (circle one) **Laterally Braced** **Not Braced**

If Braced: Dimensions of knee brace _____ x _____

Attached to post 3 ft. below the bottom chord

Attached to top chord of truss 3 ft. horizontally from post

Concentrated Loads. Specify amount of load and point of attachment to truss. May require a sketch. (EXAMPLE - a 300 lb. piece of equipment attached to the lower chord 20 feet from the face of the inside walls)

(Form continued on next page)

Wind Design Data for Truss Engineering

Basic Wind Speed (MPH) : _____ (Figure 2.5 - taken from FIG. 6-1 ASCE 7-95)

Building eave height : _____ feet _____ inches

Building width : _____ feet _____ inches

Building length : _____ feet _____ inches

Building Occupancy

The proposed structure is designed to be a: _____ (circle one)

- **dry manure stacking shed**
- **dead animal composting barn**
- **stacking shed/composter combination**

Trusses may be metal or wood and shall be designed to handle the loads specified by the Natural Resources Conservation Service (NRCS) planner. Trusses may be pre-fabricated, manufactured trusses. All truss designs shall be approved (signed and sealed) by a registered professional engineer. A copy of the truss certification shall be provided to the NRCS approving official prior to truss installation.

Manufactured trusses will be installed in accordance with the manufacturer's instructions, on the spacing compatible with the design. Trusses shall have a minimum of twelve (12) inches of overhang and more overhang is advisable.

Truss anchorage and associated supports shall be as shown on the drawings or other acceptable method as approved by the NRCS engineer. Bracing details shall be provided by the truss manufacturer.

NRCS building planner : _____

Date : _____

Truss manufacturer : _____

Manufacturer's representative : _____

Date : _____